



REMARKS

In response to the above Office Action, claims 1-12 have been cancelled and replaced by new claims 13-18 to more specifically claim applicants' invention, avoid the rejection of the claims under § 112, and generally to place the claims in more traditional U.S. format.

New main product claim 13 is a combination of former claims 1 and 4, in which the ester-forming monomer is limited to 1,3-propanediol.

New main method claim 14 is a combination of former claims 5-10 with the monoalcohol limited to methanol and the basic substance to a basic metallic salt. Support for the former can be found on page 12, lines 21 and 22, and the latter on page 10, lines 21-24. Support for claims 15 and 16 dependent from claim 14 can be found, for example, in former claim 2.

Claims 17 and 18 are similar to former claims 11 and 12, respectively, rewritten in independent form, but where the ester-forming monomer is limited to 1,3-propanediol.

With respect to the rejections of claims 5-6 and 8-10 under 35 U.S.C. § 112, first paragraph, in the new claims, "monoalcohol" has been limited to methanol. Further, "basic substance" has now been defined as a "basic metallic salt capable of exhibiting an alkaline pH of from 8 to 14."

Regarding claim 11, now claim 17, and recitation of the L and b values of the claimed polymer, which values are also set forth in new claim 18, these have been defined as "brightness-indicating L value" and "yellow-indicating b value" as set forth on page 13, lines 20-31 of the specification. These are measures of brightness and whiteness, and hence, the quality of the polymer and are well known to those skilled in

the art. Often, they are written as "L*" and "b*", and applicants mean the same thing here in the expression "L" and "b".

L and b values are color values according to the L*, a*, b* color notation system (Hunter color notation system) of a color object recommended by the Commission Internationale del' Eclairage (CIE) in 1976, and also defined in JIS-Z8729-1994 (Japanese Industrial Standard). The notation system is used as a conventional means for representation of brightness, color, and degree of whiteness of a material, for example, a polymeric resin, fiber, and the like. L is a measure of brightness, the greater the L value the brighter is the material, and b a measure of the yellowing tint of the material, the greater the b value of the material, the more yellow tinted the material is. In claims 17 and 18, the claimed "L value" and "b value" have this meaning.

Accordingly, it is believed the claims now define the invention as required by § 112, first paragraph, and its withdrawal as a ground of rejection of the claims is requested.

One aspect of the present invention relates to 1,3-propanediol containing acrolein in an amount not greater than 0.5 wt% and having a Hazen Color No. of 40 or less that has been obtained from the depolymerization of poly(trimethylene terephthalate) (hereafter "PTT"), particularly waste PTT.

The claimed 1,3-propanediol provides an ester-forming monomer of high purity, so that a polymer with quality equivalent to or above that obtained using virgin monomer can be obtained from it even when the monomer is reused for polymer production. In this connection, reference is made to the following Table A, which is Example 4 as set forth on pages 17 and 18 of the specification.

Table A (Example 4)

Raw monomers		3GT polymer	
<u>DMT</u>	<u>PDO</u>	L value	b value
Commercially available	Recovered in Example 1	88	2.1
Commercially available	Commercially available	85	8

DMT = dimethyl terephthalate

PDO = 1,3-propanediol

3GT = poly(trimethylene terephthalate)

Because the reactivity of 1,3-propanediol is relatively higher than that of ethylene glycol, the recycled use of ester-forming monomer recovered from the depolymerization of waste polytrimethylene terephthalate is hampered by the generation of acrolein and its reactivity as discussed in the specification (see page 3, line 14 to page 4, line 36).

When a recycled ester-forming monomer, e.g., 1,3-propanediol, is reused as a polymerization starting material for 3GT, the polymerization rate is slowed and the whiteness of the 3GT obtained is not acceptable unless the acrolein content of the monomer is reduced to a prescribed amount. Another problem is the acrolein is a reactant with 1,3-propanediol, which greatly impedes separation of the recovered ester-forming monomer by distillation or the like.

It is inevitable in a reaction involving a depolymerization of 3GT that a portion of the 1,3-propanediol produced by the depolymerization thereof readily converts into acrolein or allyl alcohol and that, once acrolein is generated in the depolymerization system, the resulting reaction product causes further reactions leading to conversion to numerous different high boiling point substances close to that of 1,3-propanediol. This

makes their separation difficult to perform. For distillation of dialkyl terephthalate, such as methyl terephthalate, similar problems are encountered. When obtaining terephthalic acid, acrolein and acrolein degeneration products included in the terephthalic acid make separation by recrystallization difficult.

On the other hand, the aforementioned problems do not exist in recovered monomers obtained by the depolymerization of PET. The decomposed product, ethylene glycol, can produce side-reaction products, but the side-reaction product, acetoaldehyde, which hardly reacts with ethylene glycol, can be separated with ease, e.g., by distillation (see specification at page 4, line 37 to page 5, line 15).

Thus it is necessary to avoid the generation and the presence of acrolein in the recovery process. The ester-forming monomer (recovered 1,3-propanediol) of claim 13 where the presence of acrolein has been avoided can be obtained by the process set forth in claim 14. This process comprises:

(1) reacting a poly(trimethylene terephthalate) with 1,3-propanediol to obtain bis (3-hydroxypropyl) terephthalate and/or an oligomer thereof;

(2) reacting the bis (3-hydroxypropyl) terephthalate and/or an oligomer thereof with methanol in the presence of a basic metallic salt capable of exhibiting an alkaline pH of from 8 to 14 to produce an ester-forming monomer; and

(3) isolating the ester-forming monomer while keeping the basic metallic salt in complete or partial non-neutralization.

The process first produces bis (3-hydroxypropyl) terephthalate and/or its oligomer <step (1)>, and then methanol is allowed to react therewith in the presence of a basic metallic salt <step (2)>, and finally, 1,3-propanediol and dimethyl terephthalate

are recovered as ester-forming monomers <step (3)> (see the specification at page 12, lines 15 to 24).

The basic metallic salt used in step (2) is an essential component for converting the acrolein to non-volatile or non-soluble substances, or substances with very low volatility or solubility, thereby preventing inclusion of the acrolein or acrolein degeneration products in the ester-forming monomer isolated by procedures, such as distillation, recrystallization, precipitation, and the like. The basic metallic salt also has the effect of increasing the recovery efficiency by inhibiting repolymerization by the catalyst added to the 3GT during isolation of the produced ester-forming monomer, for example, by distillation. If an acidic substance is used instead, the depolymerization reaction is appreciably lowered, while the acidic substance acts as a catalyst to accelerate dehydration of the 1,3-propanediol, thereby lowering the purity of the recovered monomer (see the specification at page 9, line 28 to page 10, line 15). As noted above, in the specification, a polymer with quality superior to that using virgin monomers was obtained using this recovered monomer. Note that it had greater brightness and whiteness than the polymer made from virgin monomer.

In the Office Action, the Examiner rejected claims 1-4 and 11-12, now claims 13, 17, and 18, for being anticipated under 35 U.S.C. § 102(b) by WO97/49652 to Gallagher (hereafter "Gallagher"), and claims 5-10 for being obvious under 35 U.S.C. § 103(a) over Gallagher.

Gallagher discloses a method for recovering depolymerization products from polymers, such as polyesters and polyamides. The process is characterized in the use of a solid support matrix to aid the depolymerization and vapor phase stripping of the

monomer for polymer recycling, especially for polyester and polyamide (see page 3, lines 35 to page 4, line 2). As the starting (waste) polyester, polyethylene terephthalate (PET), poly-propylene terephthalate, and poly(1,4-butylene) terephthalate are mentioned. For PET, the products include ethylene glycol, dimethyl terephthalate, and bis-beta-hydroxyethyl terephthalate. For other polyesters, the products include C₂ to C₁₆ diols, such as 1,3-propanediol and 1,4-butane diol.

The depolymerization agent for the polyester can be a low molecular weight oligomer of a polyester, an alcohol, such as methanol, monomer, or an alkanediol, especially, ethylene glycol, and water (see page 7, lines 9 to 16 of Gallagher). By stripping gas is meant a material that is a gas at reaction temperature and pressure and is able to carry away the volatile products. The stripping gas may be the depolymerization agent itself as long as such depolymerization agent yields a volatile product, for example, alcohol and alkanediol for PET. The stripping gas passes through the reaction vessel and carries away the volatile monomers (see page 7, lines 27 to 33).

Gallagher describes complete depolymerization of polyester by methanolysis, using methanol in the vapor phase (see page 7, lines 9-26; page 30, claim 11). In the typical methanolysis of PET, the operating temperature can range from about 220 to about 250°C (see page 11, lines 13 to 21). Examples 24 to 27 relate to 3GT in which decompositions are carried out at a maximum temperature of about 225°C using methanol as the depolymerization agent (concurrently also as stripping agent) for 12 hours to obtain recovered residues.

It is acknowledged that 1,3-propanediol is one of the products obtained by the depolymerization of 3GT (= PPT) in Examples 24 to 27 of Gallagher. However, 1,3-propanediol containing acrolein in an amount not greater than 0.5 wt% with a Hazen Color No. less than 40, as set forth in claim 13, is not found in any of the teachings of Gallagher. No component of the residues recovered in the examples of Gallagher is given, although each residue appears to be a mixture of common reaction products, including terephthalate, 1,3-propanediol, bis-(3-dihydroxyether) terephthalate, etc. No isolated single reaction product is described in these examples of Gallagher. However, in the Examiner's opinion, such characteristics of the product would be inherent in the 1,3-propanediol product of Gallagher in the absence of evidence to the contrary.

As discussed above, the product of claim 13 is the product of the process of claim 14, which process specifically uses a basic metallic salt to minimize the unwanted production of acrolein so that the 1,3-propanediol produced in the depolymerization process contains 0.5 wt% or less of acrolein. As discussed in greater detail below, this feature of the process is not taught in the process of Gallagher, and more particularly, the process set forth in Examples 24-27 of Gallagher. Consequently, Gallagher could not have produced 1,3-propanediol having the claimed acrolein content and, therefore, claim 13 cannot be considered anticipated by this reference. The same is true with respect to claims 17 and 18, since they claim the same 1,3-propanediol. Withdrawal of Gallagher as a ground of rejection of claims 13, 17, and 18 under § 102 is therefore requested.

With respect to the process of claim 14, Gallagher teaches a process for recovering ester-forming monomers from 3GT by depolymerizing the 3GT polymer to

produce the monomers, followed by isolating each monomer by distillation or other conventional means.

Gallagher may show step (1) above, but steps (2) and (3) above and in claim 14 are neither described nor obvious from what is described in the reference. In Gallagher, neither generation of acrolein in the depolymerization and isolating system of the monomers, nor the significance of the presence of acrolein in the isolated monomer, and in a polymer therefrom are recognized. Accordingly, no one skilled in the art would be taught by this reference how to minimize the amount of acrolein in the isolated ester-forming monomer. More particularly, no one would be taught to convert the generated acrolein to non-volatile or non-soluble substances, or substances with very low volatility or solubility by the use of the claimed basic metallic salt, to thereby prevent inclusion of the acrolein or acrolein degeneration products into the ester-forming monomer obtained.

As discussed above, this is a result of steps (2) and (3), neither of which are disclosed or even remotely suggested by Gallagher. Since steps (2) and (3) in the process of claim 14 lead to improved results, namely, an ester-forming monomer of very low acrolein content, it cannot be said that such a process would be obvious in view of Gallagher. PH per se may be a result effective variable, as maintained by the Examiner, but here it is being used to define the basic metallic salt used in the process, which salt is not taught or suggested for use in the depolymerization process of Gallagher.

As set forth in M.P.E.P. § 2143, to establish a prima facie case of obviousness under § 103, all of the claim limitations must be taught in the cited reference. Since

Gallagher fails to teach or suggest in his process the use of a "basic metallic salt having alkaline pH of from 8 to 14," it is submitted that neither claim 14 nor its dependent claims 15 and 16 can be considered obvious in view of this reference. Its withdrawal as a ground of rejection of the claims under § 103 is therefore requested.

It is believed claims 13-18 are in condition for allowance.

Please grant any extensions of time required to enter this response and charge any additional required fees to our deposit account 06-0916.

Respectfully submitted,

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